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The Resistance of Certain Red Clovers and Alfalfas to Leafhopper Injury.

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The Resistance of Certain Red Clovers and Alfalfas to Leafhopper Injury.

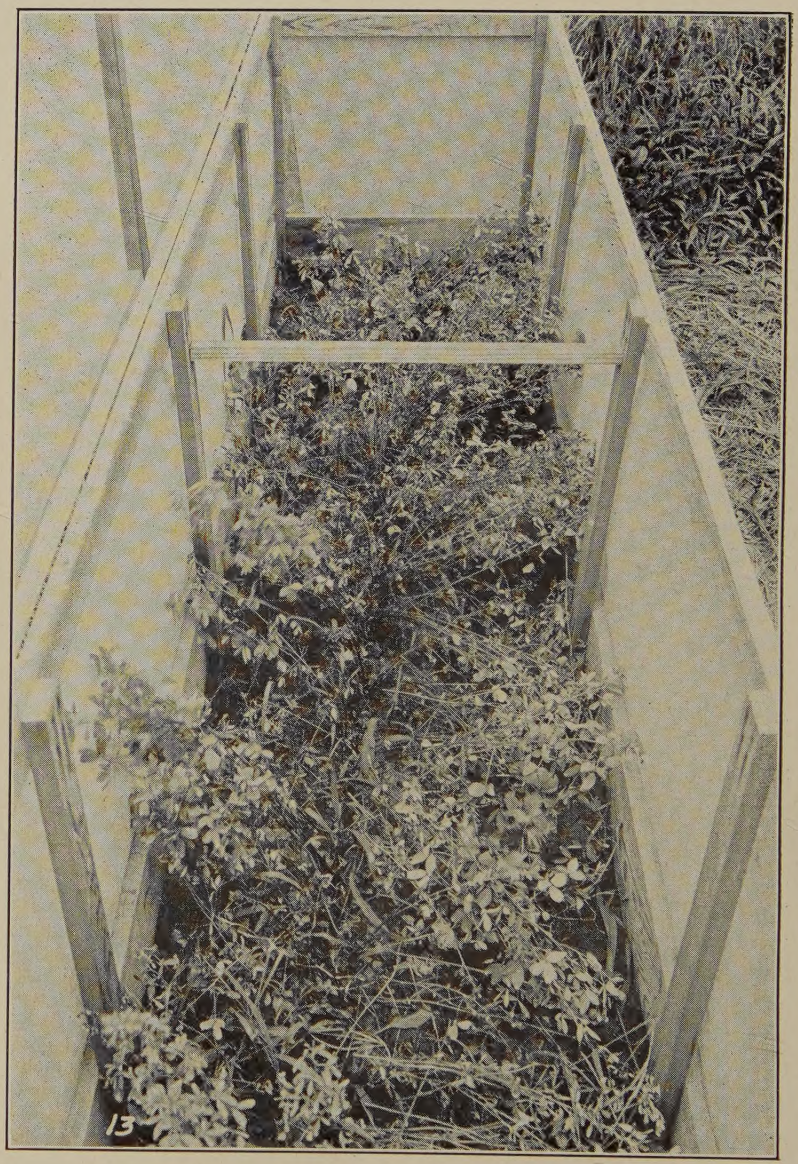
By H. H. JEWETT

The leafhopper, *Empoasca fabae,* does a great deal of damage to clover and alfalfa. In a series of experiments made in 1928, it was found that hopper injury often resulted in the death of young plants, or the plants were more or less dwarfed, the leaves of clovers became reddish or brownish and the leaves of alfalfa turned yellow. During this study which lasted thru the seasons of 1929 to 1931, it was observed that certain varieties of clovers were more resistant than others to the attack of hoppers. The non-pubescent clovers or those with appressed pubescence were generally more severely injured than the clovers with rough hairy pubescence. An adapted Kentucky red clover was found to be the least affected by hopper injury during the season of 1928.

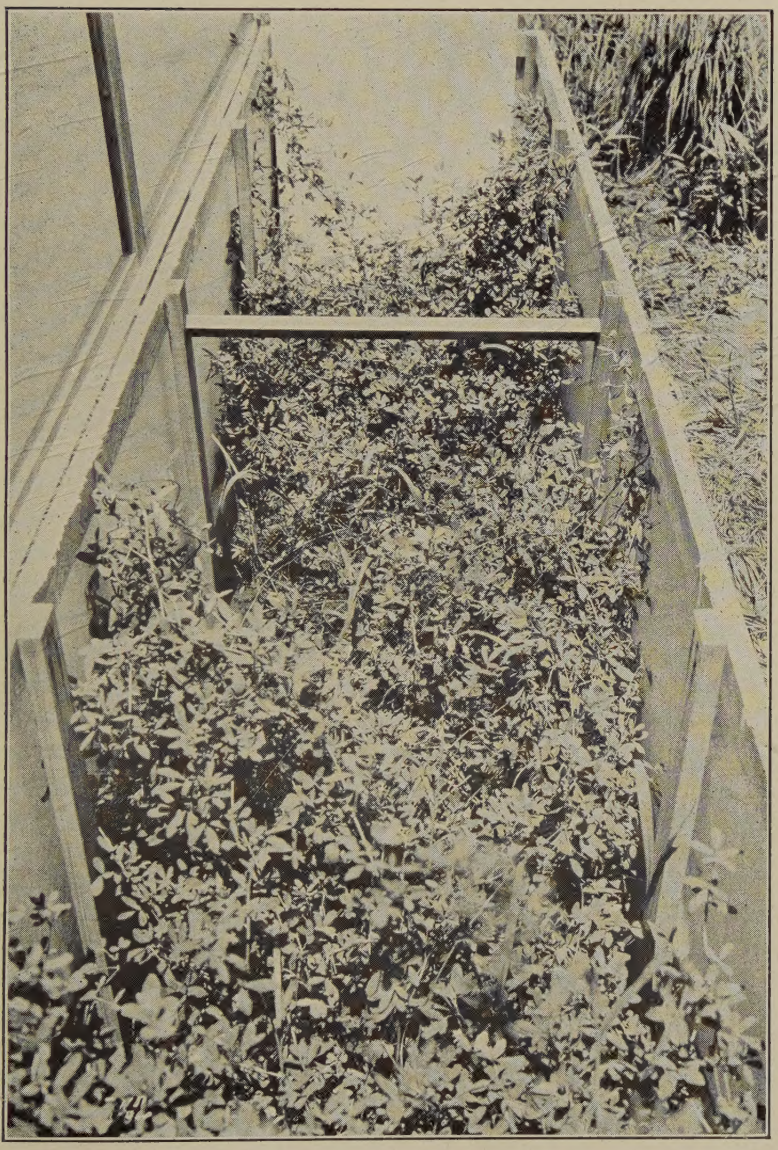
The clovers and alfalfa used in the experiments were grown from seed from different localities and were studied as to their ability to resist hopper injury. In a general way, the relative resistances of these clovers to injury was compared with that of the Kentucky red clover. The results of these studies are herein reported.

METHODS OF PROCEDURE.

The clovers and alfalfas were grown in the field under insect-proof cages which were ten feet long and two feet square at the ends. Before planting the seed, the soil was steam-sterilized by the same method used in steaming tobacco beds. This was done for the purpose of killing insects and weed seed in the soil. The



Kansas common alfalfa which has been injured by the leafhopper



Kansas common alfalfa the same age as that shown on the opposite page, but which is free of leafhopper injury.

different clovers and alfalfa were grown in sets of two in order to have a check in each set. The seed for each year's tests was planted on the same day, but there was variation in sowing dates for the three seasons. The plants in the cages were fumigated with hydrocyanic acid gas the day before the first leafhoppers were introduced. The same number of hoppers were used in the cages during the three season's tests. The plants when clipped were air dried and the weights recorded. The plants used in the tests in the Insectary were grown in eight-inch pots and for each test were graded as nearly as possible as to size and condition of growth. These tests were conducted as nearly as possible under the same conditions of moisture, lighting and temperature.

FIELD EXPERIMENTS.

Experiment 1929. A part of the data collected in connection with these experiments is summarized in Table I. The hoppers were placed in the cages on June 1 to June 7 in equal numbers on the same day until there were 125 female and 100 male hoppers in each cage. The hoppers were collected from potatoes.

All infested clovers and alfalfa were more or less dwarfed by the leafhopper injury and when dried weighed less than the uninfested plants. The differences in weight, however, of the infested and uninfested plants were not always as great as the dwarfing would indicate, because the dwarfed plants were sometimes slightly thicker and more branched.

The Kentucky clover was the least affected by the hoppers of any of the clovers and the Michigan and Minnesota clover next in order. These two clovers, however, showed more of the dwarfing effect from hopper injury than did the Kentucky clover. The Italian clover showed the greatest amount of loss from hopper injury and the Idaho next in amount of loss, even greater than the French clover. The appearance of the leaves of the Idaho and Oregon clovers was similar to that of the French and Italian clovers. There was a great deal of discoloring of the leaves and dwarfing was pronounced. The three

alfalfas showed little resistance to hopper injury and there was practically no difference in percentage of reduction in yields. The loss in weight in each case was large.

TABLE 1. FIELD EXPERIMENTS, 1929.

Kind of Plant	Height of Plants in Inches			Date When Cut	Weight When Dried		Percent Loss
	At Beginning of Expr.	When Cut					
		Infested	Check		Infested Grams	Check Grams	
Clovers							
Kentucky 1	8	21	24	July 16	425	460	7.6
Italian 2689	8	15	28	July 15	260	670	61.3
French 14485	8	15	28	July 15	405	600	32.5
Idaho 3	7	15	25	July 15	250	450	44.4
Michigan 14455	8	20	26	July 15	360	405	11.1
Oregon 4	9	18	26	July 15	320	495	35.3
Minnesota 2	9	16	23	July 15	270	310	12.9
Alfalfas							
Ontario Variegated	8	15	24	July 12	165	390	66.3
Kansas Common	8	15	24	July 12	105	335	68.6
N. Dakota Common	8	15	24	July 12	135	405	66.7

The growth of the plants in the cages, after they had been clipped, varied greatly and many died. The Kentucky clover was the least affected and showed the least amount of dwarfing. The death of the plants evidently was caused in part by a disease, since all Italian clover plants, both infested and uninfested and all the infested plants of the French clovers died. A greater number of infested plants of all the other clovers and alfalfas died than uninfested. While the hoppers may not have been responsible for the death of all these plants, they were evidently a factor of considerable importance. The infested plants of all the clovers and alfalfas except the Kentucky clover did not attain the same growth of their corresponding checks. A record of the number of dead plants is found in Table 2.

Experiments in 1930. The clovers and alfalfa of the 1930 season were affected by the drouth and high temperatures. Apparently the high temperatures lessened the multiplication of the leafhoppers. The hoppers were difficult to find in the spring and it was not until July 3 that sufficient numbers had been collected for the tests. The clovers were from 10 to 12

TABLE 2. DEAD PLANTS FOUND FROM JULY 12 TO SEPT. 30, 1929.

Plant	Percent of Dead Plants		Height of Plants in Inches Sept. 30	
	Infested	Check	Infested	Check
Kentucky	3	1	17	20
French	100	5		22
Idaho	55	8	7	20
Michigan	40	5	9	17
Oregon	20	4	9	15
Minnesota	67	4	6	12
Ontario Variegated Alf.	57	4	15	30
Kansas Common Alf.	75	8	14	28
N. Dakota Alf.	67	1	13	27

TABLE 3. FIELD EXPERIMENTS, 1930.

Kind of Plant	Height of Plants in Inches			Date When Cut	Weight When Dried		Per-cent Loss
	At Beginning of Expr.	When Cut First Time					
		Infested	Check		Infested Grams	Check Grams	
Clovers							
Kentucky 1	10-12	17	21	July 18	170	220	19.5
French 14485	10-12	15	20	July 18	135	205	34.1
Wisconsin 4	10-12	14	18	July 18	140	200	30.0
Oregon 1	10-12	12	19	July 18	130	180	27.9
Idaho 3	10-12	14	20	July 18	200	260	23.1
Alfalfas							
Kansas Common 1	12-14	16	22	July 18	280	320	12.5
Kansas Common 2	12-14	18	23	July 18	300	335	10.4
Kansas Common 3	12-14	15	22	July 18	245	295	16.9
Kansas Common 4	12-14	15	22	July 18	222	265	17.1
Ontario Variegated	12-14	16	24	July 18	270	320	15.6

TABLE 4. FIELD EXPERIMENTS, 1930.

Kind of Plant	Height of Plants in Inches When Cut Second Time		Date When Cut	Weight When Dried		Per-cent Loss	Average Loss for Two Cuttings
	Infested	Check		Infested Grams	Check Grams		
Clovers							
Kentucky 1	10	12	Sept. 16	89	135	34.1	26.8
French 14485	8	12	Sept. 16	60	105	42.8	38.5
Wisconsin 4	8	10	Sept. 16	70	95	26.3	28.1
Oregon 1	7	10	Sept. 16	120	175	31.4	29.1
Idaho 3	8	10	Sept. 16	60	100	40.0	31.5
Alfalfas							
Kansas Common 1	14	18	Sept. 18	185	260	28.8	20.8
Kansas Common 2	15	20	Sept. 18	195	285	31.6	21.0
Kansas Common 3	14	18	Sept. 18	150	250	40.0	28.6
Kansas Common 4	14	18	Sept. 18	160	235	31.9	24.4
Ontario Variegated	15	20	Sept. 18	230	310	25.8	20.7

inches tall at this time and the alfalfas 12 to 14 inches tall. The data concerning these experiments are summarized in Tables 3 and 4.

From these tables, it may be seen that all infested clovers and alfalfas were greatly affected by hopper injury. The growth of the plants after the first clipping was poor because of the drouth. The difference in weights of the clippings of the infested and uninfested Kentucky clover was less than that of any of the clovers for the first clipping, but for the second clipping, the Wisconsin 4 and Oregon 1 clovers showed less losses than the Kentucky clover. The average loss for the season, however, was slightly less for the Kentucky clover than for any of the other clovers. The infested French red clover when compared with its check showed the greatest amount of loss.

The leaves of the French and Idaho clovers were affected more by hopper injury than any of the other clovers and showed the greatest amount of brown or red discoloring. The alfalfas were less affected by the drouth and none showed any marked resistance to hopper injury, but Kansas Common 3 showed the greatest loss for the season. The leaves of all the alfalfas were yellow colored when the plants were cut.

Experiments in 1931. Several red clovers were used in the tests in the season of 1931. A Kentucky clover, three from Wisconsin, six from Oregon and one from Tennessee were included. The Oregon clovers were selected particularly because *Empoasca fabae* is not found in the western locality. The hoppers used in the tests were collected from potatoes on June 8 to June 18 and were liberated in the cages in equal numbers on the same days until there were 125 females and 100 males on each clover.

All infested clovers were more or less dwarfed by hopper injury and discoloring of leaves was noticeable in every case. The infested Kentucky clover at the first cutting showed the least loss from hopper injury and the Tennessee came next, but its loss was twice as great as that of the Kentucky clover. The three infested Wisconsin clovers were severely injured and as

TABLE 5. FIELD EXPERIMENTS. 1931.

Kind of Plant	Height of Plants in Inches			Date When Cut	Weight When Dried		Percent Loss
	At Beginning of Expr.	When Cut First Time			Infested Grams	Check Grams	
		Infested	Check				
Clover							
Ky. 1	8	22	27	July 17	305	320	4.7
Wisc. 4	8	18	28	July 17	275	360	23.6
Wisc. 3	6	20	28	July 17	260	335	22.4
Wisc. 7	6	19	28	July 17	255	345	26.1
Oreg. 1	7	23	29	July 17	305	370	17.6
Oreg. 2	7	20	30	July 17	275	325	15.4
Oreg. 3	7	20	28	July 17	254	314	19.1
Oreg. 6	7	20	29	July 17	310	360	13.9
Oreg. 7	7	20	25	July 17	323	386	16.3
Oreg. 8	7	20	30	July 17	265	355	25.4
Tenn. 6	7	22	28	July 17	365	404	9.7

TABLE 6. FIELD EXPERIMENTS, 1931.

Kind of Plant	Height of Plants When Cut Second Time		Date When Cut	Weight When Dried		Percent Loss	Average Loss for Two Cuttings
	Infested	Check		Infested Grams	Check Grams		
Clovers							
Ky. 1	22	26	Sept. 17	317	345	8.1	6.4
Wisc. 4	20	27	Sept. 17	266	366	27.3	25.4
Wisc. 3	23	28	Sept. 17	325	387	16.0	19.2
Wisc. 7	21	26	Sept. 17	265	330	19.7	22.9
Oreg. 1	23	28	Sept. 17	333	379	12.1	14.8
Oreg. 2	23	28	Sept. 17	372	409	9.0	12.2
Oreg. 3	22	27	Sept. 17	346	390	11.3	15.2
Oreg. 6	25	28	Sept. 17	350	380	7.9	10.9
Orge. 7	22	27	Sept. 17	322	365	11.8	14.0
Oreg. 8	20	26	Sept. 17	341	397	14.1	19.7
Tenn. 6	25	28	Sept. 17	420	460	8.7	9.2

is shown in Table 5 lost from 22.4 percent to 26.1 percent in weights. Of the Oregon clovers, number 8 showed the least resistance to hopper injury and the loss in weight was relatively the same as that for three Wisconsin clovers.

The clovers made good growth after the first cutting and only in case of Wisconsin 4 was there any very noticeable dwarfing of the plants. The clovers least affected by the hopper after the first cutting were Oregon 6, Kentucky 1 and Tennessee 6 in the order given, but the difference in losses for these three

clovers was slight. The three Wisconsin clovers again showed relatively larger losses from hopper injury than any of the other clovers and Oregon 8 had the greatest loss of any of the Oregon clovers. The average loss in weights for the infested clovers when compared with uninfested was the least for the Kentucky clover and greatest for Wisconsin 4. The Oregon 8 clover had the greatest loss of any of the Oregon clovers.

HOST PREFERENCE.

The leafhopper, *Empoasca fabae*, is found in the field in the greatest numbers on the non-pubescent clovers, those that have appressed hairs on the foliage. In general, more nymphs are produced on the non-pubescent clovers than on the pubescent clovers. This was found to be true in tests where the adult hoppers were confined upon pubescent and non-pubescent red clovers in separate cages and in tests where adult hoppers were confined upon pubescent and non-pubescent red clovers in one cage. In tests where adult hoppers were confined on two or more pubescent red clovers, the number of nymphs produced was about the same for each clover.

Distribution of Hoppers on Clovers in the Field. The relative numbers of hoppers on different clovers in the field were determined in 1929 from several collections obtained by sweeping several plots of clovers. This is not an accurate method of getting counts, but it may well indicate degrees of infestation. Collections made on August 1, 5 and 9 gave an average of 126.3 hoppers for a French red clover, 40.6 for a Kentucky red clover and 42.5 for a Tennessee red clover. Collections from other plots made on August 2, 8, 14 and 26 gave an average of 112.5 for a French red clover, 19 for a Tennessee red clover, 41.5 for an alsike clover, 118 for an Italian red clover, 31.7 for an Oregon red clover, 33 for a Michigan red clover, and 25.5 for a Wisconsin red clover. From these collections, it can be seen that more hoppers were found on the French and Italian red clovers.

Production of Nymphs on Different Clovers. During the season 1929 to 1931 a number of experiments were made to determine whether or not more hoppers were produced on certain

kinds of red clovers. In one set of tests, made in 1929, two red clovers were placed in separate cages and equal numbers of hoppers were put into each. The records are in Table 7. In 13 of the 14 tests where pubescent native clovers and non-pubescent foreign clovers were used, more nymphs were collected from the non-pubescent clovers. In test No. 7, more nymphs were collected from the pubescent Kentucky clover. In test No. 15 where French and Italian red clovers were used, more nymphs were collected from the Italian clover.

TABLE 7. THE CLOVERS WERE IN SEPARATE CAGES AND AN EQUAL NUMBER OF HOPPERS WERE PLACED IN EACH. 1929.

Time Hoppers Were in Cages	No. Females in Each Cage	Kind of Clover and the No. of Nymphs from Each				No. of Test
June 18 to July 24	10	Ky.	13	Italian	76	1
July 16 to July 22	15	Ky.	21	Italian	70	2
July 16 to July 22	10	Ky.	29	Italian	63	3
July 18 to July 24	10	Ky.	34	Italian	50	4
July 18 to July 24	10	Ky.	17	Italian	56	5
July 24 to July 30	10	Ky.	6	Italian	29	6
July 24 to July 30	10	Ky.	33	Italian	22	7
July 25 to July 31	10	Ky.	24	Italian	40	8
July 25 to July 31	10	Ky.	15	Italian	28	9
July 25 to July 31	10	Ky.	10	Italian	17	10
June 12 to June 15	10	Tenn.	28	Italian	130	11
Aug. 22 to Aug. 29	10	Tenn.	15	Italian	24	12
Aug. 22 to Aug. 29	10	Tenn.	15	Italian	21	13
June 24 to July 1	10	Tenn.	27	French	44	14
June 20 to June 26	10	French	84	Italian	100	15

Three other sets of tests were made in which two or more clovers were placed in cages and the hoppers had a selection of host plants for egg deposition. In the second set of tests in 1929, recorded in Table 8, 12 tests were made in which a pubescent native clover and a non-pubescent foreign clover were used The number of nymphs found on the non-pubescent clover in every case was larger than on the pubescent clover. In tests 28 and 67, where two pubescent clovers were used, there was a little difference in the number of nymphs found on the clovers. The tests made in 1930 are recorded in Table 9. In the tests, where the Kentucky and Oregon clovers were used, a few more nymphs were collected from the Oregon clovers and in the tests where the non-pubescent French and Italian clovers were used more nymphs were collected from the Italian clover.

TABLE 8. NUMBER OF NYMPHS COLLECTED FROM DIFFERENT KINDS OF CLOVERS. 1929.

Time Hoppers Were in Cages	No. Females in Cages	Kind of Clover and the No. of Nymphs from Each				No. of Test
June 12 to June 15	50	Ky.	47	Italian	181	27
June 18 to June 21	50	Ky.	39	Italian	182	30
June 27 to July 3	35	Ky.	25	Italian	43	38
July 6 to July 10	35	Ky.	23	Italian	82	39
July 8 to July 11	35	Ky.	11	Italian	45	40
July 8 to July 11	35	Ky.	22	Italian	42	41
July 8 to July 11	35	Ky.	20	Italian	65	42
July 25 to July 31	30	Ky.	28	Italian	40	61
July 25 to July 31	30	Ky.	9	Italian	52	62
June 11 to June 18	30	Ky.	42	French	184	22
June 18 to June 21	50	Ky.	54	French	121	29
Aug. 22 to Aug. 29	10	Tenn.	27	Italian	39	70
June 18 to June 21	30	Ky.	48	Tenn.	46	28
Aug. 22 to Aug. 29	10	Ky.	22	Tenn.	36	67

TABLE 9. NUMBER OF NYMPHS COLLECTED FROM DIFFERENT KINDS OF CLOVERS. 1930.

Time Hoppers Were in Cages	No. Females in Cages	Kind of Clover and the No. of Nymphs from Each				No. of Test
July 8 to July 15	20	Ky.	27	Oreg. 1,	35	23
July 10 to July 17	20	Ky.	39	Oreg. 1,	45	24
July 11 to July 16	20	Ky.	29	Oreg. 1,	37	27
July 15 to July 22	20	Ky.	48	Oreg. 1,	52	28
July 10 to July 15	20	French	12	Italian	33	25
July 11 to July 16	20	French	46	Italian	58	26

A number of experiments were made in 1931 in which native red clovers were used and the hoppers were allowed a choice of host plants for egg deposition. In these tests, a Kentucky red clover and five Oregon red clovers were used. The Oregon clovers were selected because the leafhopper, *E. fabae,* is not found in Oregon and it was thought that the western clovers might show considerable variation in amounts of resistance to the leafhopper. In each test four clovers were placed in one cage. The number of nymphs produced is recorded in Table 10. There was some variation in the numbers of nymphs collected from the different clovers, but the differences as a whole do not seem to be large enough to be significant.

TABLE 10. NUMBER OF NYMPHS COLLECTED FROM DIFFERENT KINDS OF CLOVERS. 1931.

Time Hoppers Were in Cages	No. of Females in Cages	Kind of Clover and No. of Nymphs Collected from Each				No. of Test
July 7 to July 10	50	Ky. 15	Oreg. 1, 18	Oreg. 2, 21	Oreg. 8, 16	34
July 24 to July 28	24	Ky. 13	Oreg. 1, 17	Oreg. 2, 14	Oreg. 8, 18	42
July 24 to July 28	24	Ky. 16	Oreg. 1, 20	Oreg. 2, 17	Oreg. 7, 19	41
July 24 to July 28	50	Ky. 15	Oreg. 1, 14	Oreg. 2, 19	Oreg. 7, 25	43
July 7 to July 10	50	Ky. 25	Oreg. 1, 20	Oreg. 3, 21	Oreg. 8, 30	35
July 22 to July 27	50	Ky. 18	Oreg. 1, 19	Oreg. 3, 16	Oreg. 8, 23	39
July 10 to July 15	50	Ky. 15	Oreg. 3, 38	Oreg. 7, 31	Oreg. 8, 45	36
July 22 to July 27	50	Ky. 13	Oreg. 3, 14	Oreg. 7, 27	Oreg. 8, 26	37
July 22 to July 27	50	Ky. 29	Oreg. 3, 30	Oreg. 7, 46	Oreg. 8, 69	38
July 28 to Aug. 3	50	Ky. 18	Oreg. 3, 15	Oreg. 7, 19	Oreg. 8, 21	44
July 22 to July 27	50	Oreg. 2, 46	Oreg. 3, 10	Oreg. 7, 20	Oreg. 8, 25	40

PUBESCENCE AND RESISTANCE TO INJURY.

It has been shown by a number of tests that more nymphs are produced on the non-pubescent French and Italian red clovers than on several of the pubescent or hairy native red clovers. The part that the amount and character of the hairiness plays in rendering certain clovers less attractive to the hopper would be difficult to estimate. Succulence of foliage, chemical attraction or other factors may have much to do with attracting the insects, or some quality as toughness of the epidermis may have something to do with partially protecting certain of the clovers.

During the past three seasons, a number of red clovers were grown from seed procured from different localities and their relative resistance to hopper injuries was compared with that of an adapted Kentucky red clover; none of these clovers showed greater resistance than the Kentucky clover. For each clover used in the field tests in 1931, the number of hairs on a part of the surface of several leaf-petioles was determined and comparisons were made with the losses by the clovers from hopper injury. The counts of hairs were made on the under side of the petioles at their junctures with the leaflets. The number of hairs on the petioles varied considerably as may be seen in

Stems of two red clovers showing the character and amount of hairiness of each, a French clover at the left and an adapted Kentucky clover at the right.

Table 11. Young clovers had fewer hairs on the petioles than the older plants.

The number of hairs found on the petioles was the largest for the Kentucky clover and the loss for this clover from hopper injury was the least for the season of 1931, but the next largest number of hairs was found on the Wisconsin 4 clover and its loss for the season was the largest of any of the clovers. Table 11 also shows that the Oregon 6 and 8 clovers had practically the same number of hairs on the petioles, but Table 6 shows that the loss for Oregon 6 was only a little more than half of that of

Oregon 8 clover. The Tennessee clovers also had practically the same number of hairs as was found on the Oregon 6 and 8 clovers and it was one of the least injured clovers. For some of the younger clovers which were used in the host selection tests, the

TABLE 11. THE NUMBER OF HAIRS ON 2 SQ. MM. OF SURFACE ON PETIOLES.

1931 Kind of Clover	One Petiole from Each of 30 Mature Plants		Kind of Clover	One Petiole from Each of 10 Young Plants	
	Ave. No. Hairs	Range		Ave. No. Hairs	Range
Ky. 1	91.8	36 to 170	Ky. 1	38.3	20 to 49
Wisc. 4	75.4	25 to 142	Wisc. 4	27.6	12 to 33
Wisc. 3	61.4	30 to 201	Wisc. 3	22.5	16 to 80
Wisc. 7	63.0	24 to 160	Tenn. 6	27.2	12 to 42
Oreg. 1	67.3	24 to 206	Oreg. 1	26.3	18 to 32
Oreg. 2	59.7	28 to 100	Oreg. 2	26.1	16 to 39
Oreg. 3	58.6	30 to 115	Italian	23.1	15 to 34
Oreg. 6	69.3	39 to 165	French	26.5	15 to 41
Oreg. 7	69.6	35 to 160			
Oreg. 8	68.0	33 to 160			
Tenn. 6	69.4	48 to 108			

Kentucky and Tennessee clovers produced about the same number of nymphs and this was so in the tests where the Kentucky and Oregon 1 clovers were used. It would be difficult to say what part the amount and type of hairiness plays in reducing hopper injury, but it is probable that other factors are at least partly responsible for the resistance to injury by the leafhopper observed in some of the hairy native clovers.

LEAFHOPPER INJURY AND WINTER HARDINESS.

The clovers and alfalfas which were used in the leafhopper experiments in 1928 to 1930 were examined in the springs following these years to see if the infested plants had been winter-killed to any greater extent than the uninfested plants. The plants used in the 1928 experiments were examined on March 18, April 2 and April 26, 1929, those used in 1929, were examined on March 14, 1930, and those used in 1930 were examined on March 2, 1931. For these three years no appreciable differences were observed in the amounts of winter injury or winter killing, between plants that had been infested by leafhopper and those

that had been uninfested. The only difference observed was the size of the plants, the plants that had been infested were slightly smaller than the uninfested plants.

SUMMARY.

During the seasons of 1929 to 1931, several tests were made with clovers and alfalfas in order to observe their relative resistance to injury caused by the leafhopper, *Empoasca fabae*. Of the clovers used in these tests, the Kentucky red clover was the least affected by hopper injury and, in general, the French and Italian clovers showed the greatest amount of injury. The alfalfas, Ontario variegated, Kansas common and North Dakota common, used in the tests in 1929, had about equal amounts of losses from hopper injury. Of the four Kansas common alfalfas and an Ontario variegated alfalfa used in 1930, the Kansas common 3 had the greatest loss from hopper injury.

Collections of hoppers made in the field from non-pubescent French and Italian red clovers were larger than those from the hairy or pubescent clovers. In nearly every test when adult hoppers were placed on pubescent and non-pubescent clovers in separate cages and where adult hoppers were placed in one cage on a pubescent and non-pubescent clover more nymphs were produced on the non-pubescent clover. In the tests where adult hoppers were placed in cages on two or more hairy or pubescent red clovers, the number of nymphs produced varied for the different clovers but the differences were not great enough to appear significant.

Comparison of the amounts of losses from hopper injury sustained by certain of the clovers used in the experiments in 1931 with the amounts of pubescence of those clovers makes it appear that there is no very direct correlation between the amount of injury and the amount of pubescence and that some other undetermined factor or factors have an important function in helping resist hopper injury.

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